Irrigation Efficiency and Water Productivity in Paddy Fields in the Lower Mekong River Basin

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Fongsamuth Phengphaengsy
Okudaira Hiroshi
AIFP, MRCS

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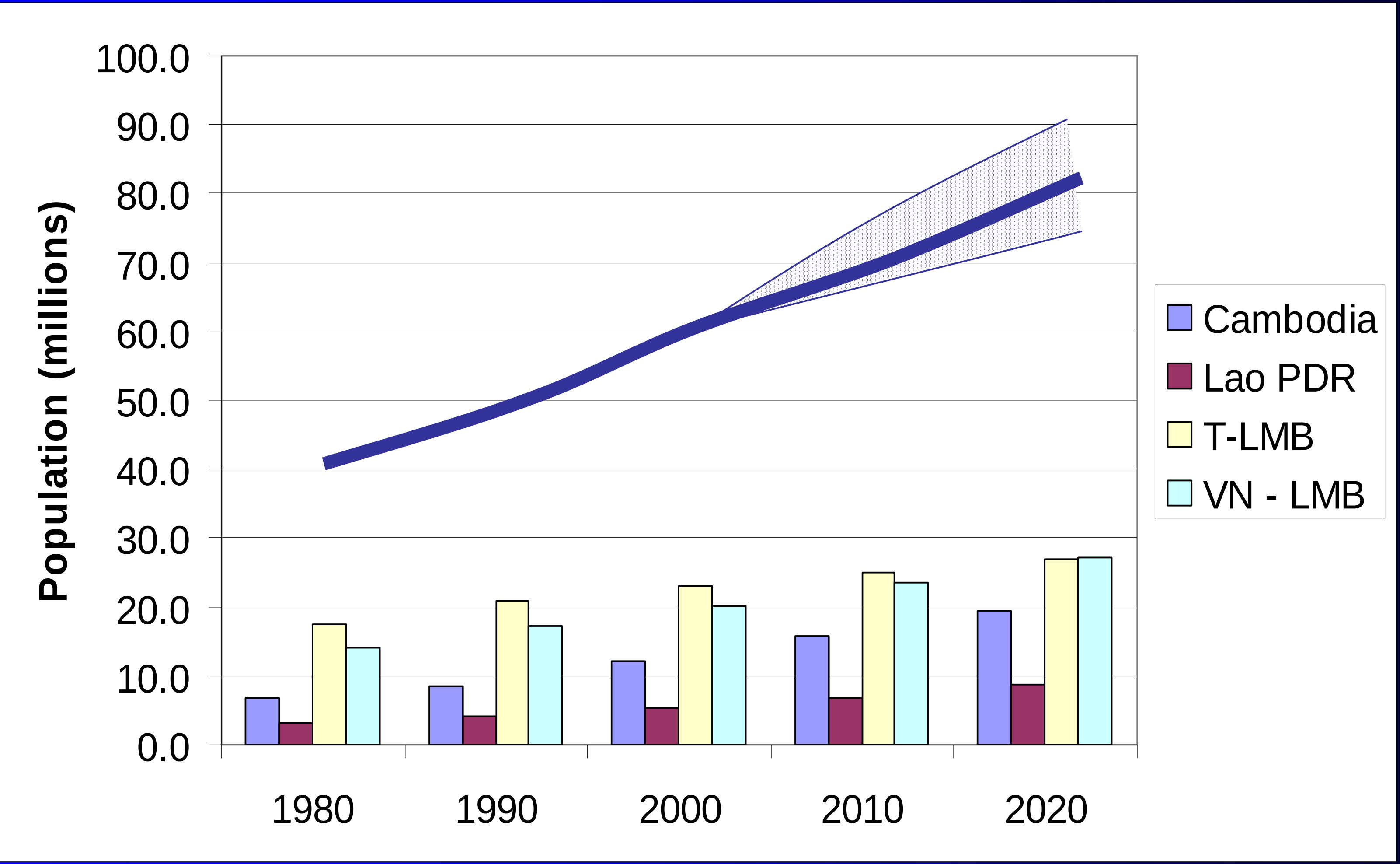
Background

- Agriculture employs > 80% of total population & is required to feed rapid growing population in the LMB region

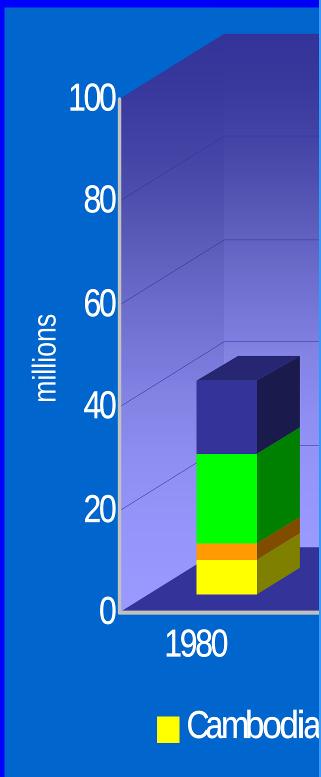
- Rice is the dominant crop and single biggest consumptive user of fresh water

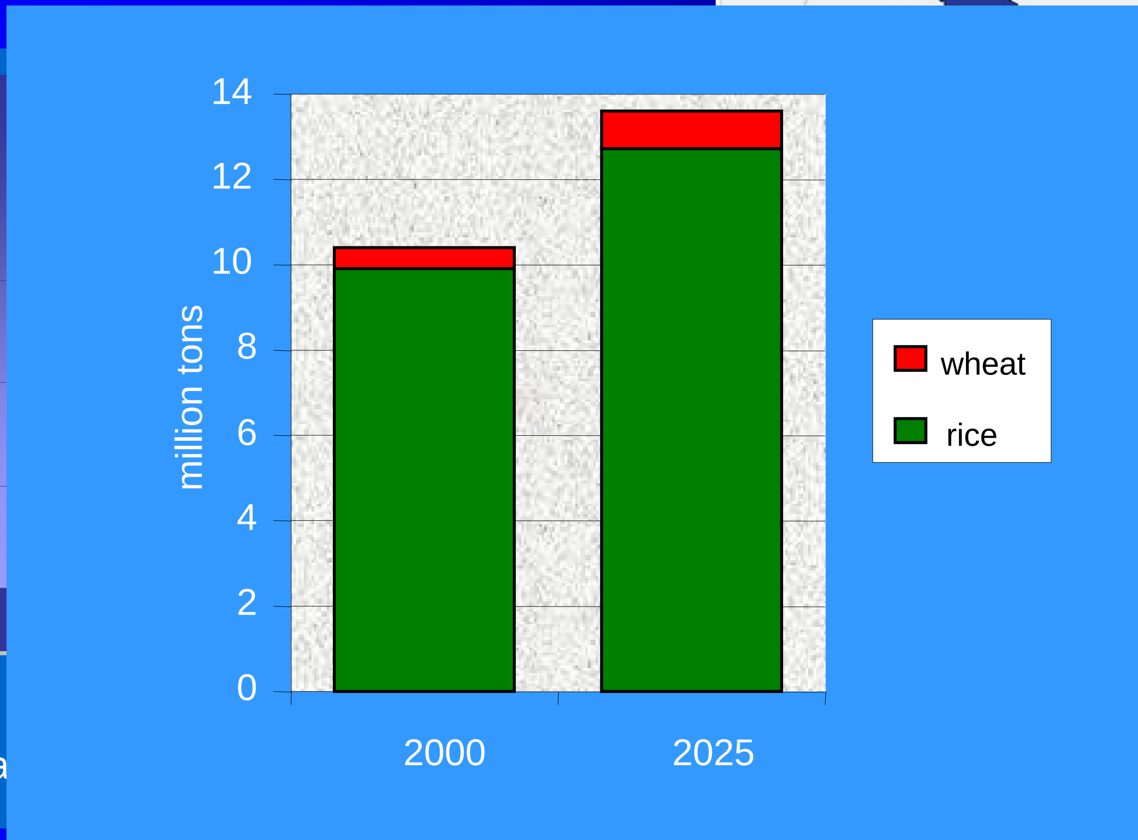
Background-Increasing Population

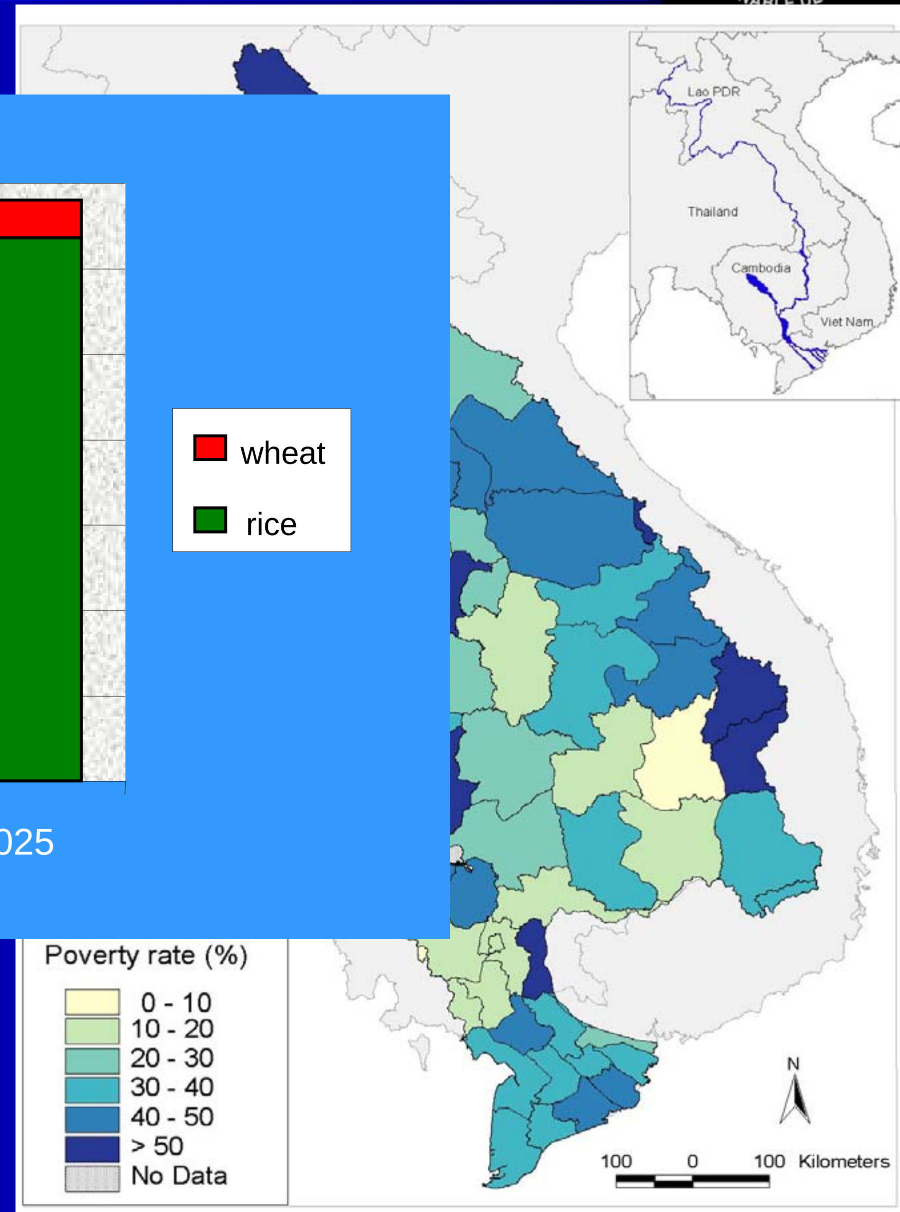


Source: **FAO AQUASTAT & IWMI WATER-SIM simulation**

Background-Increasing food demand







Agriculture, in the future, still needs to meet growing demand

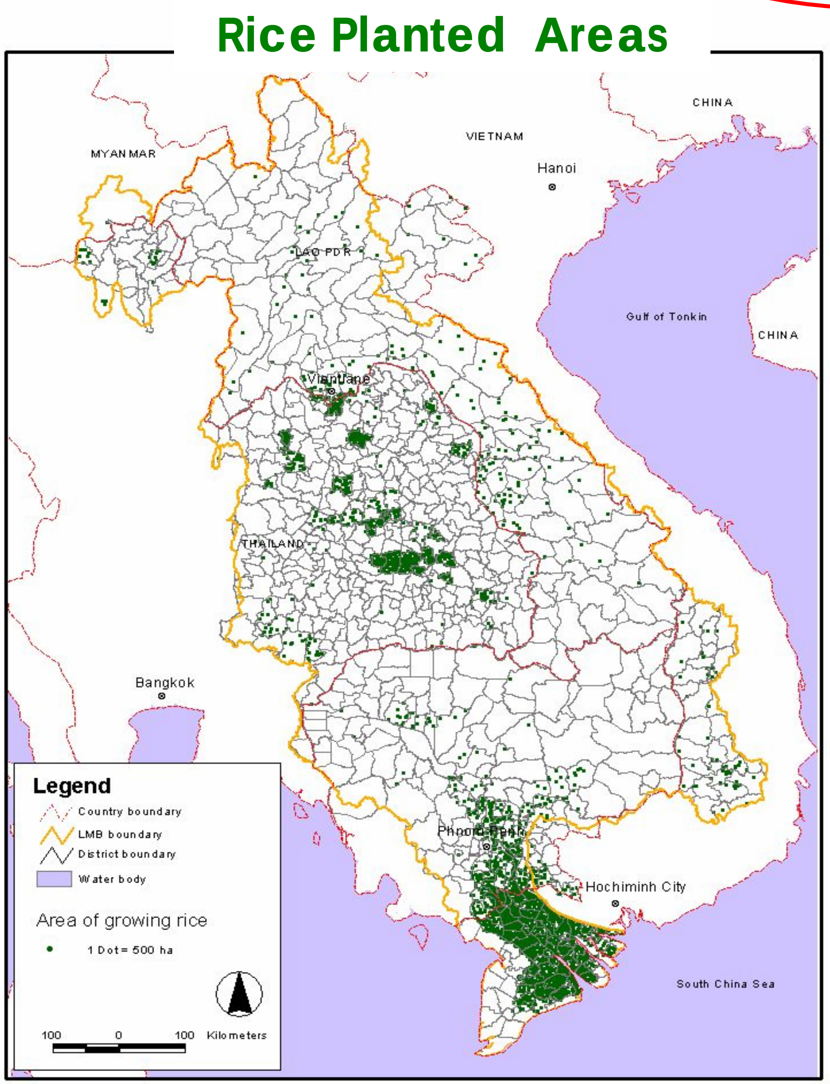
Background

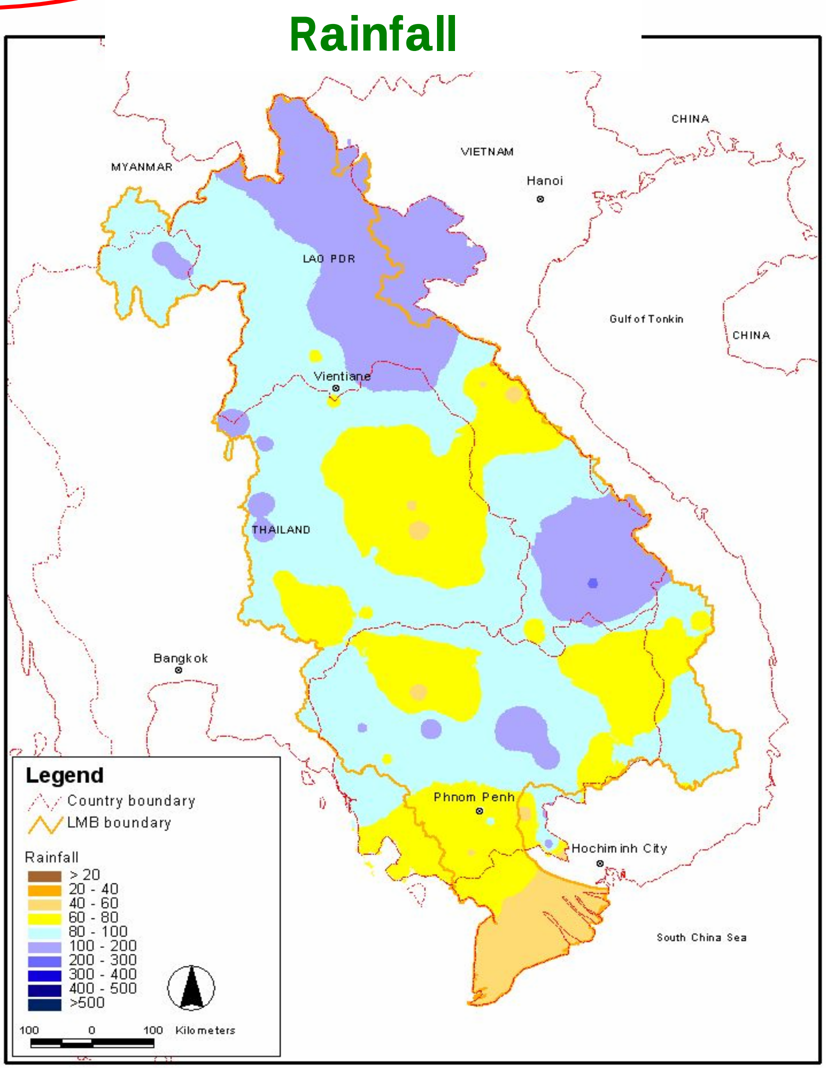
- Lack of rainfall in dry season and dry spells in rainy season are the major constraints to rice production and low water productivity

Background-Rice Planted Area & Rainfall

April

2004

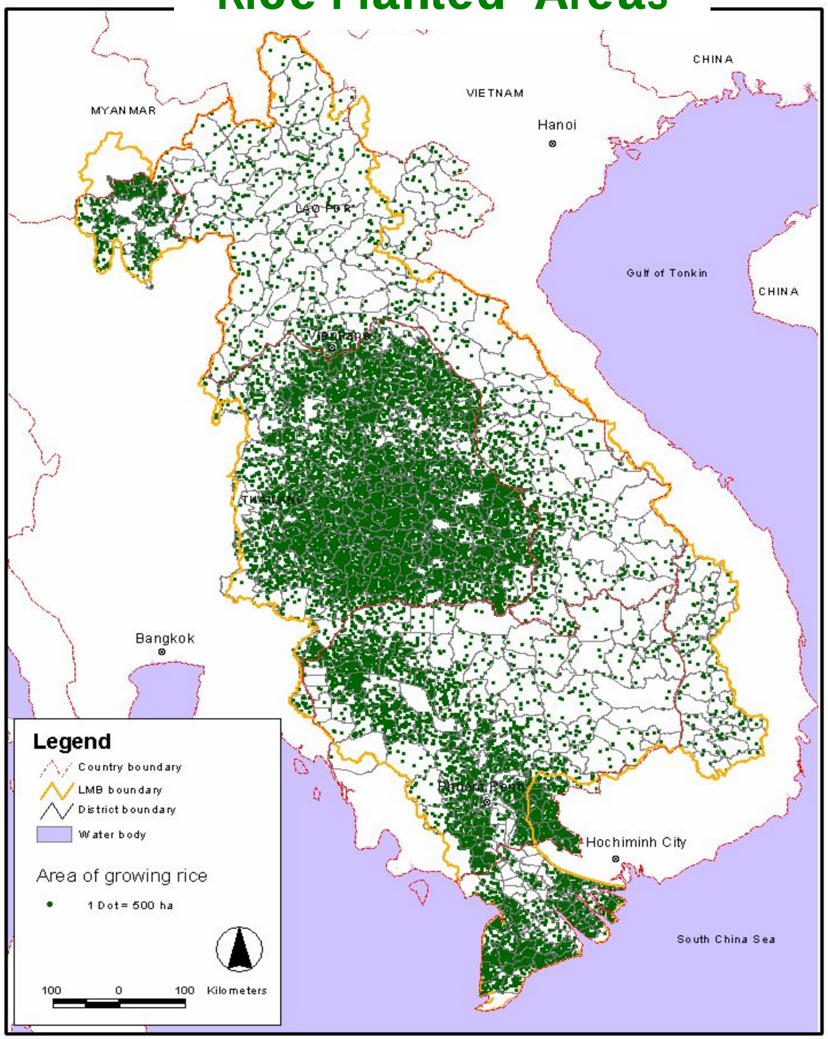




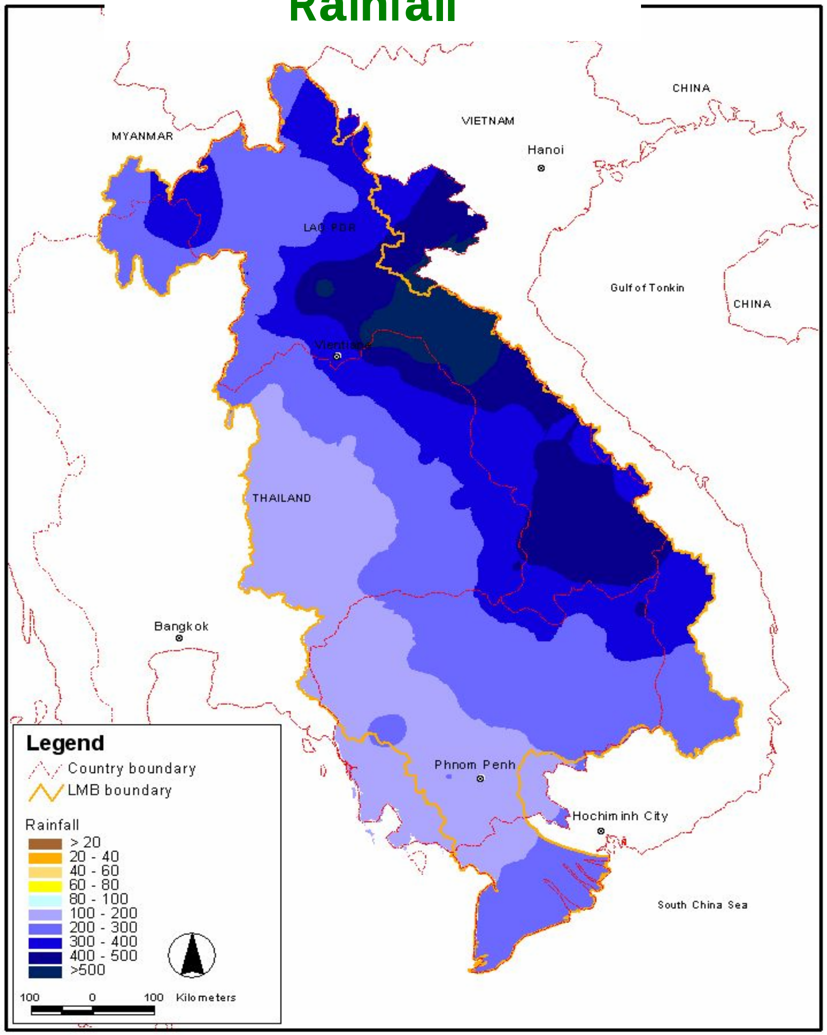
Background-Rice Planted Area & Rainfall

August

Rice Planted Areas



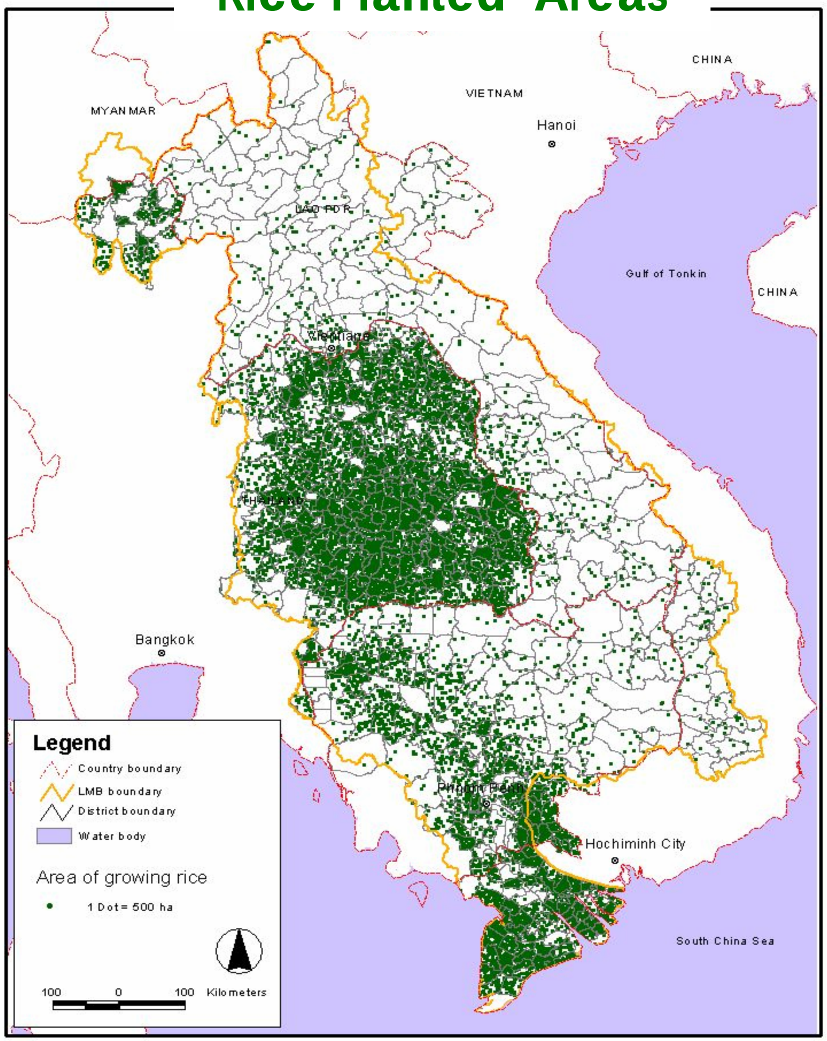
Rainfall



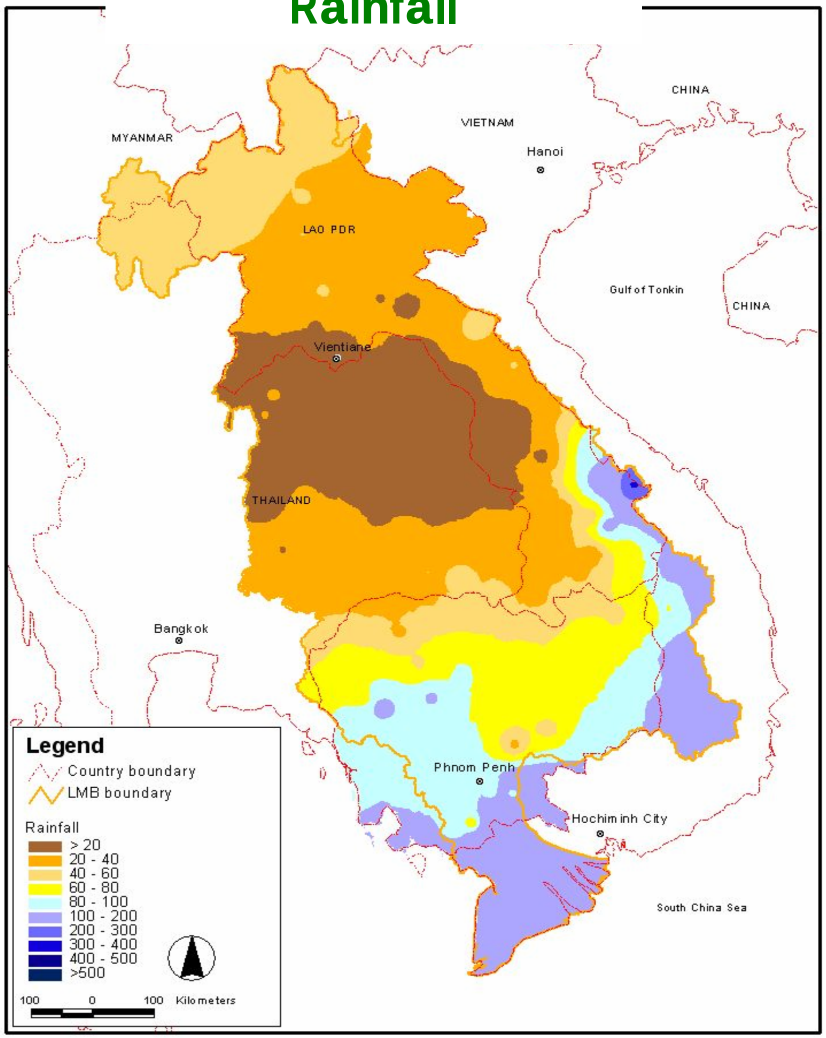
Background-Rice Planted Area & Rainfall

November

Rice Planted Areas



Rainfall



Estimation of irrigation water use

Annual water use (billion m³)	
Cambodia	2.7
Laos	3.0
NE Thailand	9.4
Vietnam Delta	26.3
Vietnam Highlands	0.5
LMB total	41.8

- **8.8%** of annual discharge (475 bill. m³)

MRC's strategy with irrigation

- MRC's Strategic Plan 2006-2010 which supports the effective use of the Mekong's water and related resources to alleviate poverty while protecting the environment
- Efficient use of irrigation water is a priority if gains in crop production are to be realized
- Irrigation efficiency is important indicator of effective water resource management
- A few analysis of efficiency in the region

Project objectives

- to appraise irrigation efficiencies in selected irrigation systems
- to enhance the capacity of stakeholders in using up-to-date concepts of irrigation efficiency and water balance tools and procedures for their assessment
- to produce guidelines for improving irrigation efficiency on paddy fields based on actual water use practices in the LMB member countries

How to improve irrigation efficiency in the LMB?

Intensive Observation in Water Use

Observed Irrigation efficiency

Assessment of Management practices

Supplement by FAO's RAP

Constraints

Guidance as Counter-measures

Scheme level Improvement

Application Basin-widely

Improve Irrigation Efficiency in LMB

Outcome

Improve livelihood of people

Maintain the ecology and environment of the river basin

Minimize gap between crop water requirement & actual water use

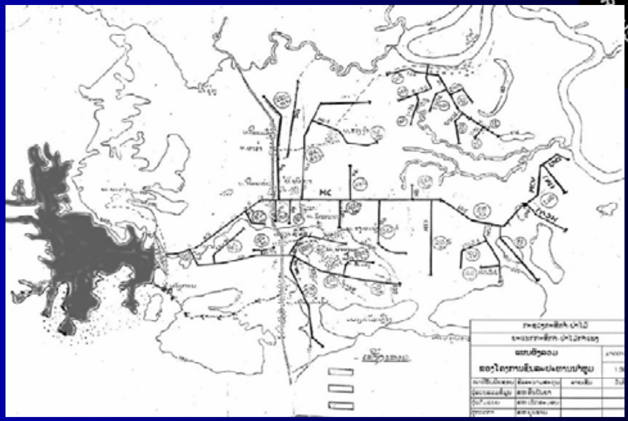
Effective of Water Use

Increase Efficiency and Water Productivity

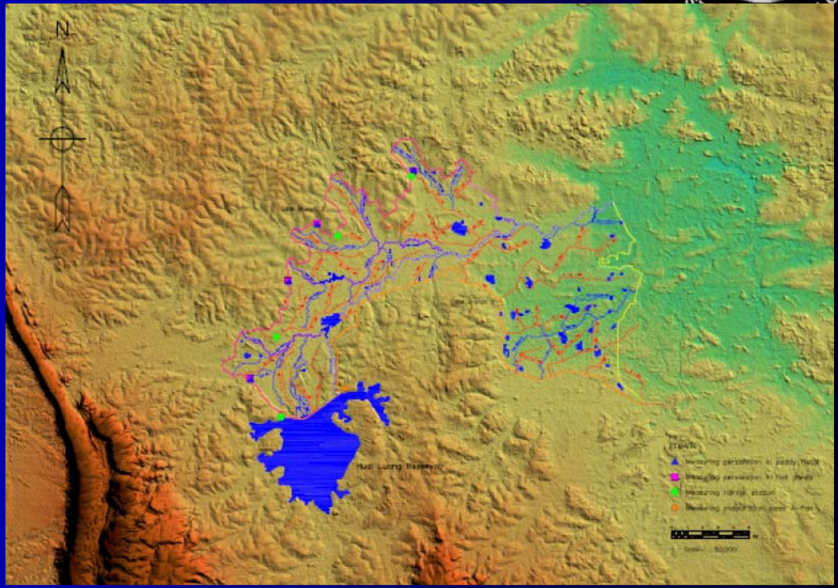
Objectives for this analysis

- To examine actual conditions of water use in pilot schemes representing irrigation typology of the LMB
- to assess irrigation efficiency and water productivity in pilot schemes applying water balance approach at scheme level
- to understand the trend of efficiencies in the typical gravity irrigation system in the LMB region

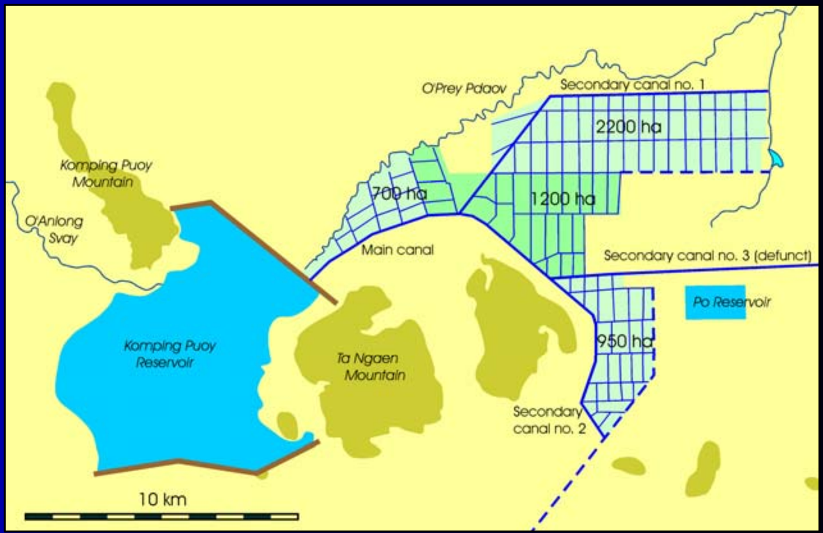
Pilot Project



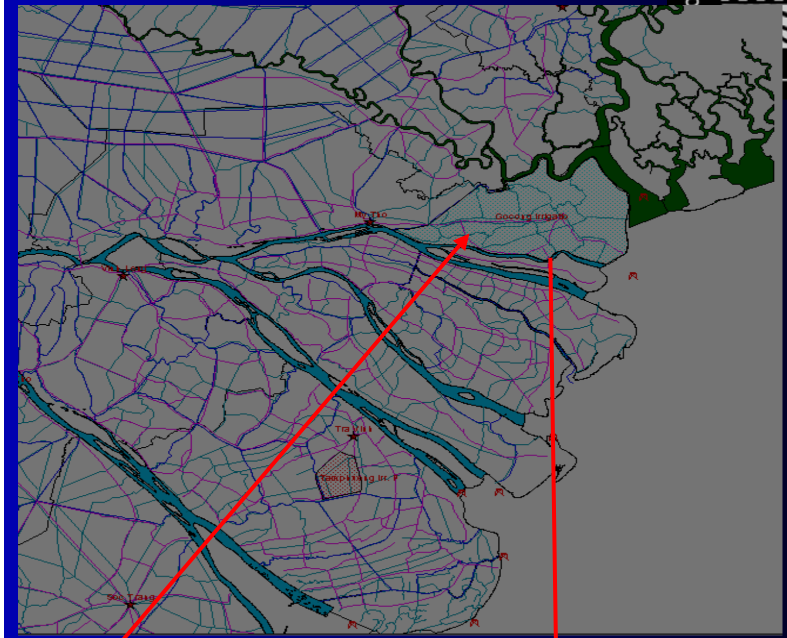
Pilot Project

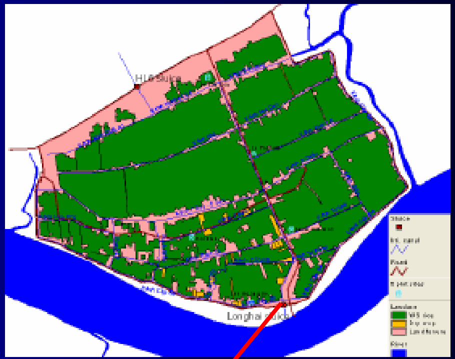


Pilot Project



Pilot Project





Data Collection

Dry Season 2006-07

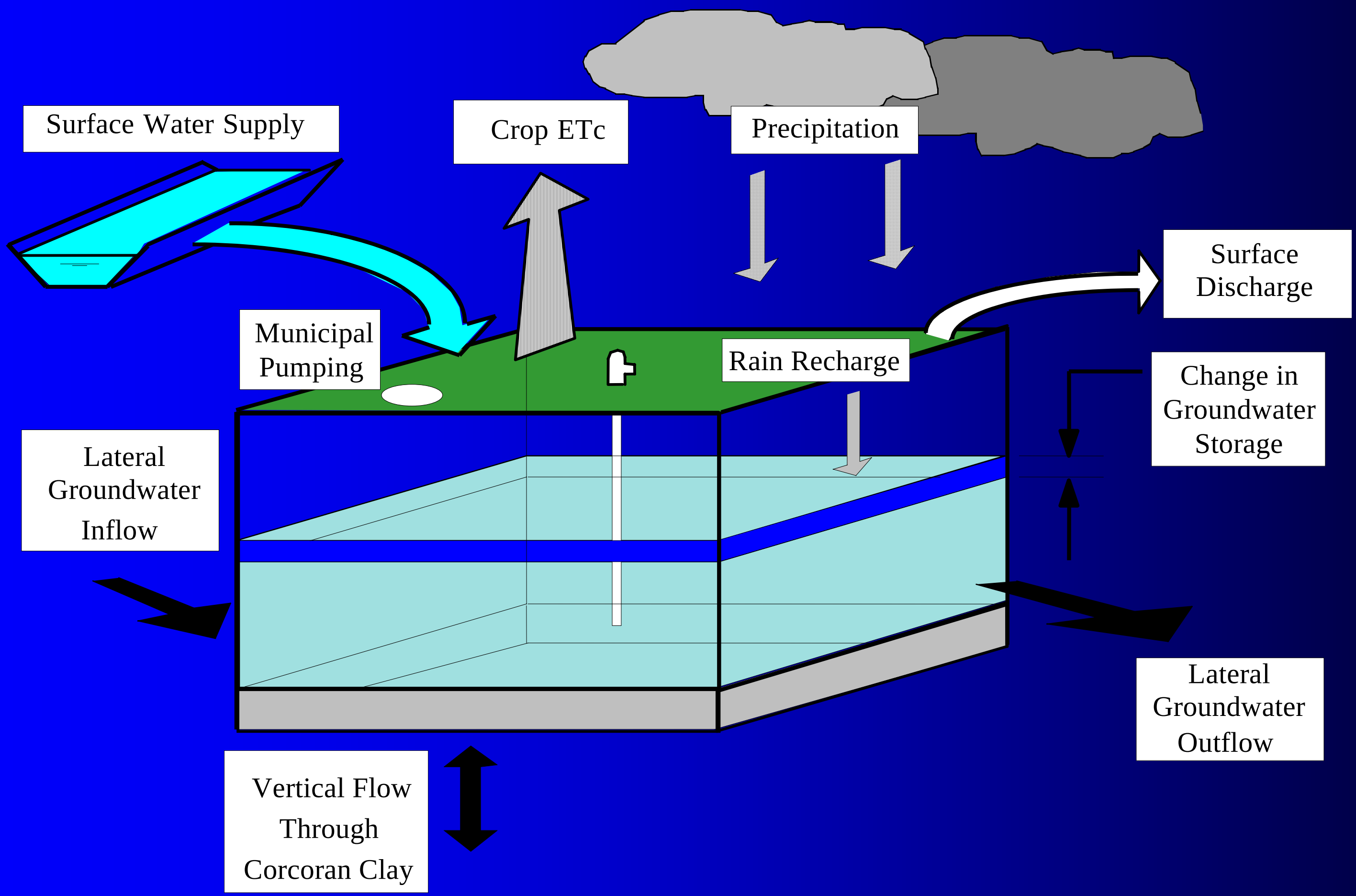
Flow measurement by Current Meter

- Measuring Inflow and outflow
- Monitoring water delivery in the scheme
- Conducting conveyance loss
- Calibrating Rated Section of Canal (H-Q curve)

Data Collection

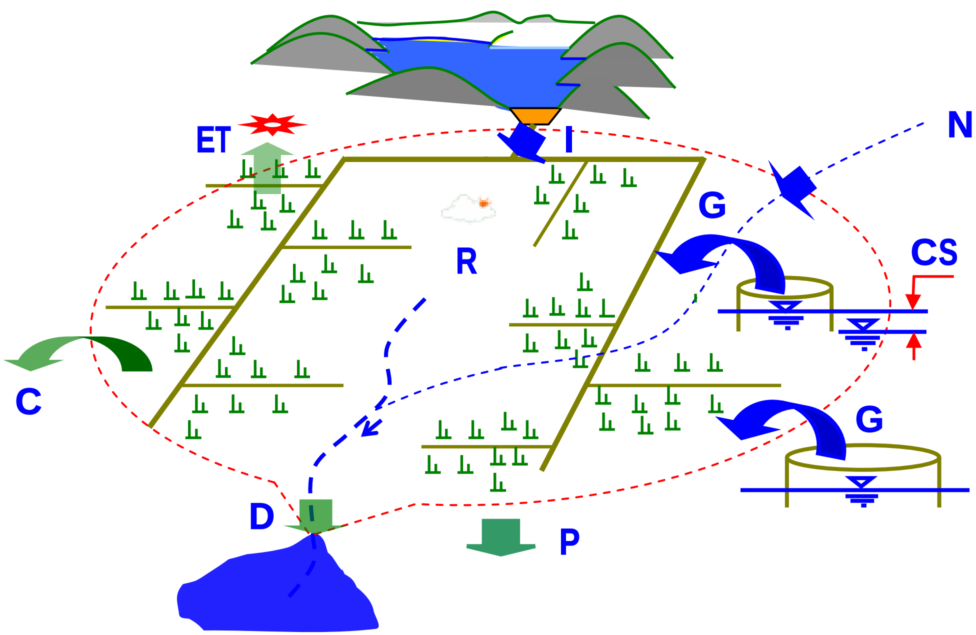
- ETc
- Percolation
- Rainfall

Water Balance Concept



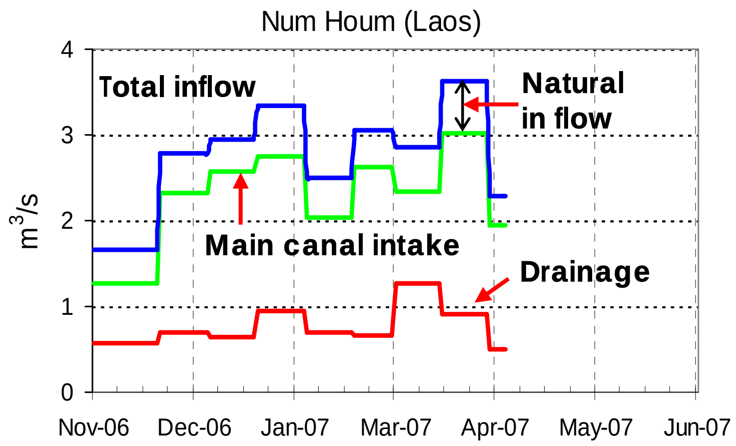
Source: FAO

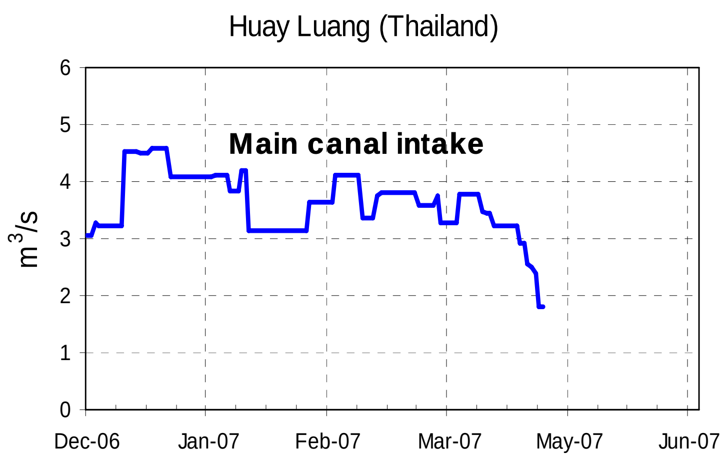
Water Balance Concept

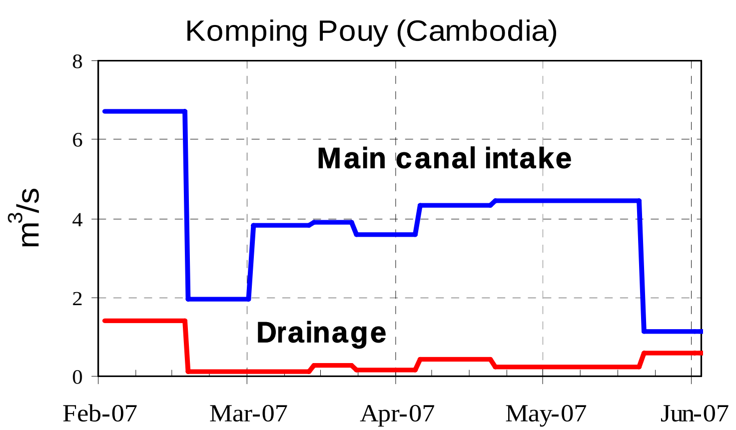


$$AWS = (R + I + N + G - CS) - (ET + P + D + C)$$

AWS : Available water supply within command area (m3)
R : Rainfall (m3)
I : Intake from main canal (m3)
N : Natural flow entering command area (m3)
G : Deep ground water from inside and outside command into the command area (m3)
CS : Changes in storage or recharge of percolation and ground water use (m3)
ET : Evapo-transpiration (m3)
P : Percolation (m3)
D : Drain water to sinks outside and without reuse or non-utilizable water supplies (m3)
C : Committed flows to the other areas, for example legally or conventionally committed outflows from command areas to outside (m3)

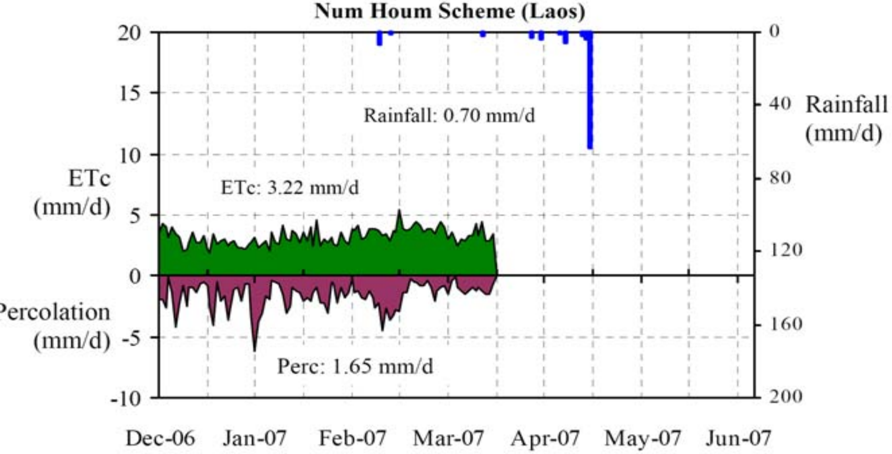


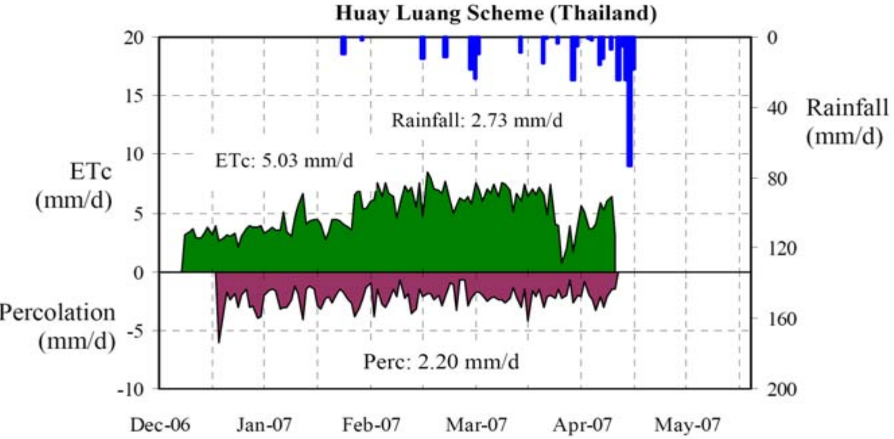


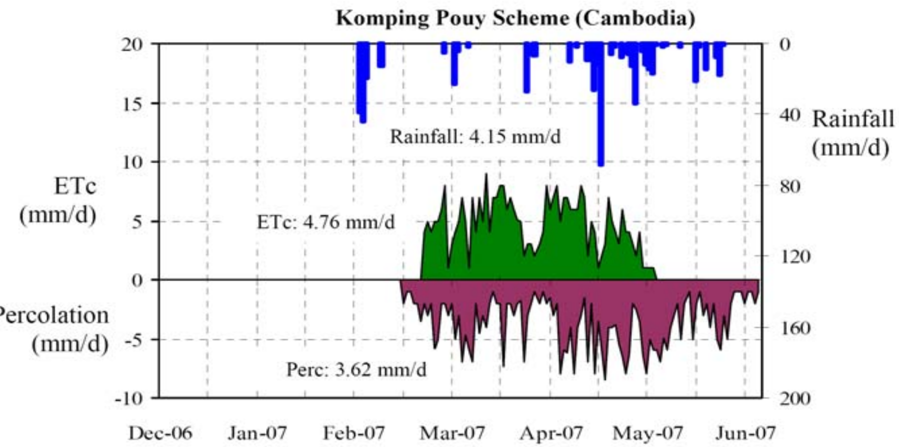


Water Supply & Drainage

- **Nam Houm (Laos)**
  water supply
  83% by main intake
  17% by natural streams
  much water drain out
- **Huay Luang (Thailand)**
  peak supply at land prep.
  approx. 20% by rainfall
- **Komping Pouy (Cambodia)**
  high peak at land prep.
  huge drain out at same time







Rain, ETc, and Perc.

- **Rainfall**
  more in lower basin
  peak Apr – May
- **ETc**
  higher than standard in L.
  clear variation in T.
- **Percolation**
  high-initial, low-late in L.
  constant in T.
  big fluctuation in C.

Water Requirement

Paddy

$$WR_p = ET_0 \times k_c + P + LP$$

Non-paddy crops

$$WR_n = ET_o \times k_c$$

Fishpond

$$WR_f = ET_o \times k_c + P$$

Total Scheme Water Requirement

$$SWR = \sum_{i=1}^{n} \int_{j=1}^{m} WR_{ji} \times A_{ji}$$

ET_o	: Potential or reference evapo-transpiration in mm/d
K_c	: Crop coefficient (dimensionless)
LP	: Land preparation in mm/d
P	: Percolation in mm/d
i	: Type of agricultural activity (e.g. paddy, non-paddy, fish farming)
j	: Day
m	: Number of days
n	: Number of agricultural activities practiced within command area
WRji	: Water requirement (mm/day x 10^{-3}) of crop type (i) at the day (j)
Aji	: Actual cultivated area (m^2) of crop type (i) at the day (j)

Overall Command Area Efficiency

$$E_{overall} = \frac{SWR\text{ -}ER}{WDF} \times 100$$

$$ER = \sum_{i=1}^{n} \left[10 \times A_i \times (1 - 0.006\, R_i) R_i\right]$$

$$WDF = (I \times E_c + N)\text{-}(D + C)$$

Where

E overall	: Overall Command Area Efficiency (%)
SWS	: System Water Supply (m^3)
ER	: Effective Rainfall (m^3), from FAO
WSF	: Water Delivery to the Fields (m^3)
A	: Progress planted Area (ha)
I	: Intake water through main canal (m^3)
N	: Total natural flows entering command area (m^3)
D	: Drain water to sinks outside and without reuse or non-utilizable water supplies (m^3)
C	: Committed flows to other areas (e.g. legally or conventionally committed outflows from command areas to outside (m^3)

Overall Command Area Efficiency

- High efficiency in pilot sites compared with existing infor. (40-50% in Laos), (40-60% in NE Thailand)
- High efficiency in Numhoum in Laos, although poor infrastructure. The active water management at on farm level by WUG
- Among pilot sites, low efficiency in Komping Pouy (Cambodia)- too large capacity of main canal which take much water into system

Pilot schemes	Scheme Water requirement (MCM)	Effective rainfall (MCM)	Water delivery to the fields (MCM)	Overall command area efficiency (%)	Canal type
Numhoum (Laos)	9.30	0.12	13.02	70. 52	Earth
Huay Luang (Thailand)	24.94	0.69	33.80	71.74	Concrete lining
Komping Pouy (Cambodia)	18.52	0.66	28.48	62.73	Earth

Water Productivities

$$WP = \frac{Value\ of\ total\ output\ (USD)}{AWS\,(m^3)}$$

AWS: Available Water Supply

- High WP in scheme practicing multi-agriculture activities
- Low WP in scheme taking much water and depending mostly on single paddy crop

Production:

- Paddy
- Non-paddy crops
- Fish
- etc

$\Rightarrow$ $

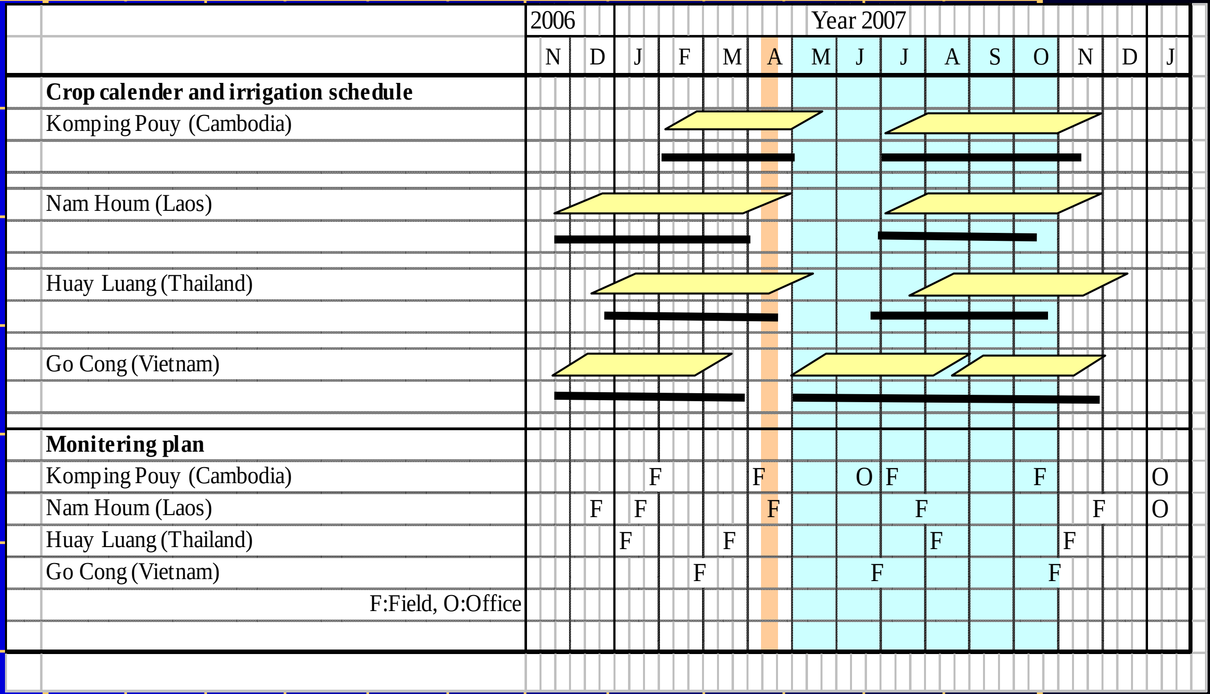
Pilot scheme	Production			AWS (MCM)	Water Productivity (USD/m³)
	Production Type	Yield (T/ha)	% of Planted area		
Numhoum Laos	Paddy	3.88	97.35	15.08	0.091
	Vegetable (cucumber)	2.54	1.23		
	Fish	4.07	1.42		
Huay Luang Thailand	Paddy	3.50	62.82	28.30	0.123
	Vegetable	18.28	32.19		
	Fish and lotus	10.25	4.99		
Komping Pouy Cambodia	Paddy	3.71	99.50	29.96	0.040
	Vegetable (sweet corn)	2.30	0.50		

Conclusion

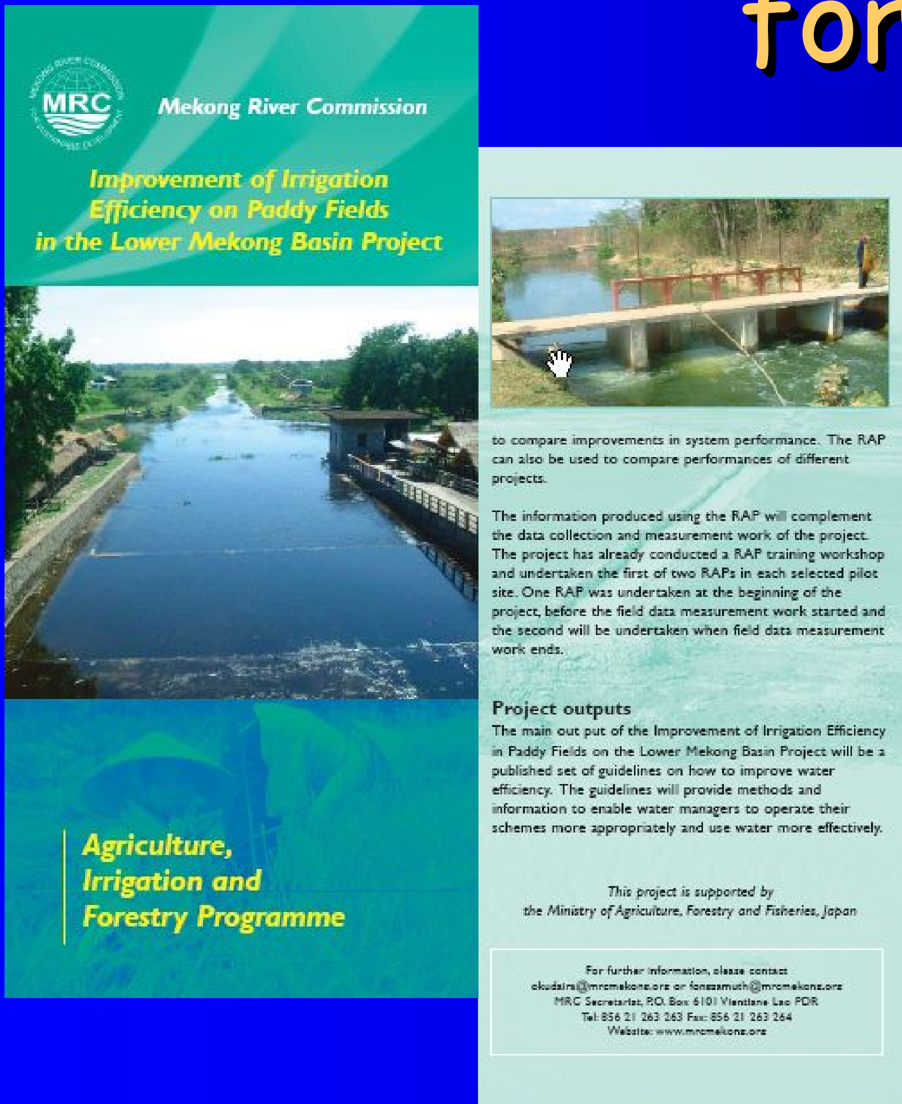
- High efficiency observed in scheme of good irrigation schedule and strong application of PIM with high degree of water delivery monitoring and evaluation
- Low efficiency caused by inappropriate hydraulic structure design, poor irrigation schedule and weakness of WUG on water delivery
- High productivity appeared with scheme practicing multi-agriculture activities
- Study will continuously examine wet-season crops in the pilot sites with emphasizing on irrigation schedule and PIM
- Water balance at scheme level counts additional water use for irrigation and is suited for efficiency at the Basin level, but not for each level of canals within system

Project Time Frame

	2005		2006				2007				2008	
	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd
Preparation stage												
Regional Workshop												
Scheme Appraisal												
Site selection												
Field observation												
Data analysis												
Review documents												
Drafting guidelines												
Finalizing												



for more Info.



Future Publication:

- Guidelines
- Technical training manual
- Published papers

Completed Publication:

- Project Brochure
- Project document
- Project technical concept
- RAP report
- Posters

http://www. mrcmekong.org/programmes/AIFP

Thank you for your kind attention